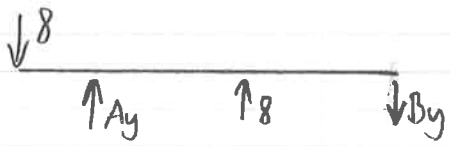
Mekanikk, eksamen 2008, kont. - Løsning

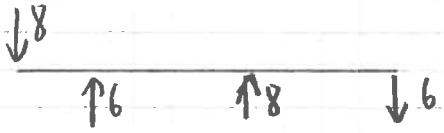
1a) FLD:



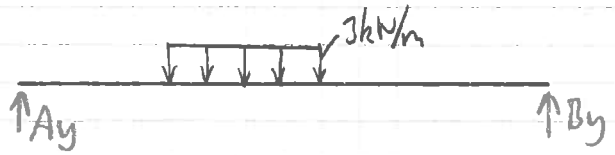
$\curvearrowright \Sigma M_A = 0$ gir $B_y \cdot 4 - 8 \cdot 2 - 8 \cdot 1 = 0 \Rightarrow B_y = 6\,kN$

$\uparrow \Sigma F_y = 0$ gir $A_y = 6\,kN$

BD:



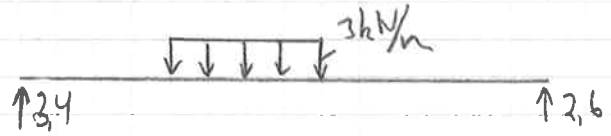
b) FLD:



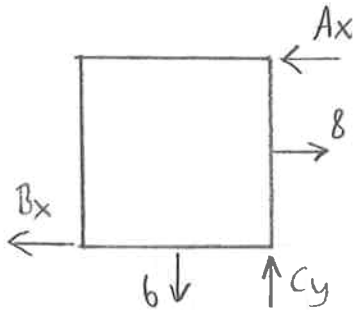
$\curvearrowright \Sigma M_A = 0$ gir $3 \cdot 2 \cdot 3 - B_y \cdot 7 = 0 \Rightarrow \underline{B_y = 2{,}6\,kN}$

$\uparrow \Sigma F_y = 0$ gir $A_y + 2{,}6 - 3 \cdot 2 = 0 \Rightarrow \underline{A_y = 3{,}4\,kN}$

BD:



c) FLD:

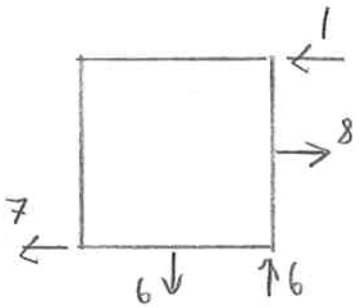


$\curvearrowright \Sigma M_C = 0$ gir $8 \cdot 0{,}5 - 6 \cdot 0{,}5 - A_x \cdot 1 = 0$ $\Rightarrow$ $A_x = 1{,}0\,kN$

$\rightarrow \Sigma F_x = 0$ gir $8 - 1 - B_x = 0$ $\Rightarrow$ $B_x = 7{,}0\,kN$

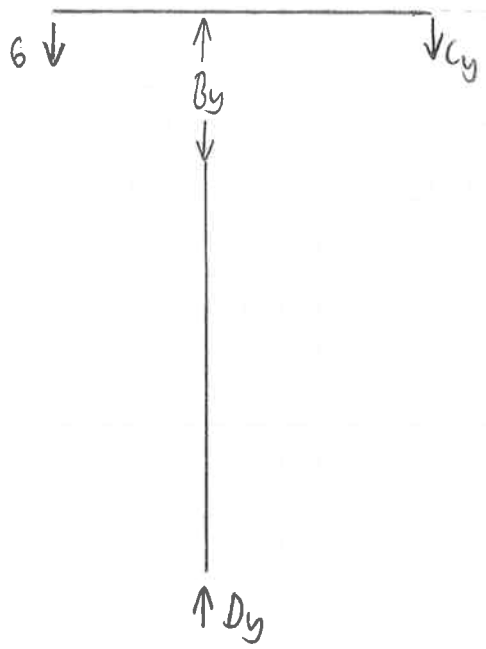
$\uparrow \Sigma F_y = 0$ gir $C_y = 6\,kN$

BD:



2a)

FLD:



Element AC:

$\curvearrowright \Sigma \hat{M}_B = 0$ gir $\quad C_y \cdot 1{,}2 - 6 \cdot 0{,}8 = 0$

$\Rightarrow \underline{C_y = 4{,}0\,kN}$

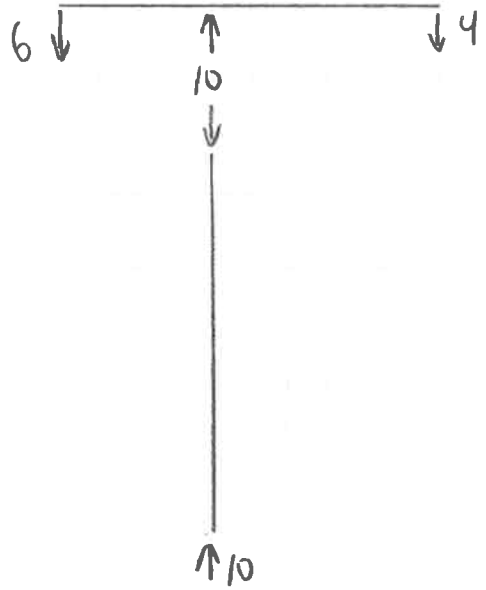
$\uparrow \Sigma F_y = 0$ gir $\quad B_y - 6 - 4 = 0$

$\Rightarrow \underline{B_y = 10{,}0\,kN}$

Element BD:

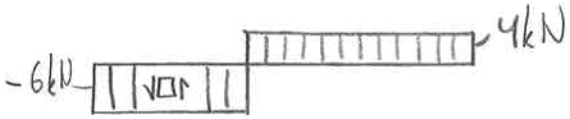
$\underline{D_y = B_y}$

BD:



2b)

V-diagram:



M-diagram:

b) Største bøyemoment finner i ved B : $M = 4{,}8\ kNm$

$$\underline{W_{nødv} = \frac{M}{\sigma_{till}} = \frac{M}{\frac{\sigma_F}{n}} = \frac{4{,}8 \cdot 10^6}{\frac{355}{2{,}0}} = 27{,}0\ cm^3}$$

Velger emnerør $\phi 108{,}0 \times 3{,}6$ med $W = 29{,}8\ cm^3$

c)

$$F_K = \frac{\pi^2 E I_0}{l_K^2} = \frac{\pi^2 206000 \cdot 161 \cdot 10^4}{3000^2} = 36{,}4\ kN$$

$$\underline{\underline{n_k = \frac{F_K}{F} = \frac{36{,}4}{10} = 3{,}6}}$$

$$\underline{\underline{\Delta l = \frac{F\ l}{A\ E} = \frac{10000 \cdot 3000}{1180 \cdot 206000} = 0{,}12\ mm}}\ (\text{kortere})$$

$I = 161\ cm^4$ og $A = 11{,}8\ cm^2$ er hentet fra tabell

3a) FLD:

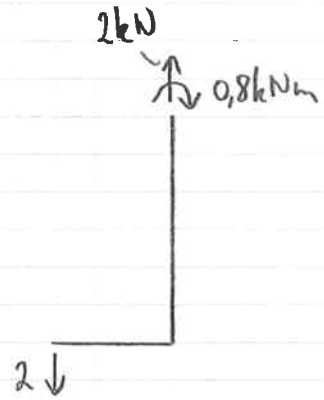
$\sum \hat{M}_A = 0$ gir $M_A - 2 \cdot 0{,}4 = 0$

$\Rightarrow \underline{M_A = 0{,}8\,kNm}$

$\uparrow \sum F_y = 0$ gir $A_y - 2 = 0$

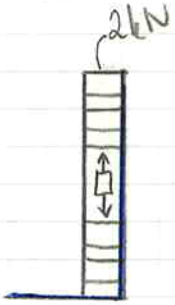
$\Rightarrow \underline{A_y = 2kN}$

BD:

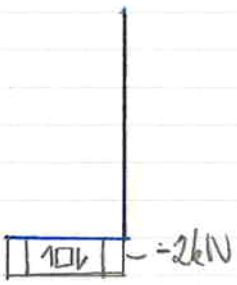


b)

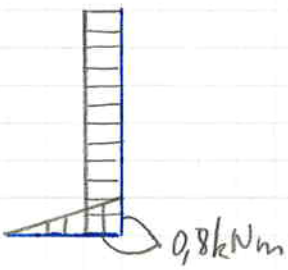
N-diagram



V-diagram



M-diagram



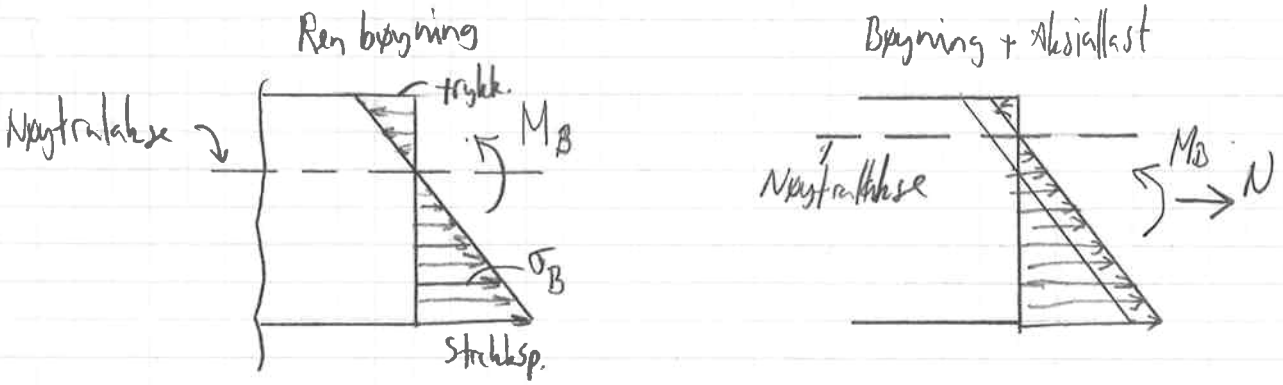
c)

$$\underline{A} = 60^2 - 52^2 = \underline{896\ mm^2}$$

$$\underline{I_x} = \frac{1}{12}(60^4 - 52^4) = \underline{471 \cdot 10^3\ mm^4}$$

$$\underline{W_x} = \frac{I_x}{y_0} = \frac{471 \cdot 10^3}{30} = \underline{15{,}6 \cdot 10^3\ mm^3}$$

Et bøyemoment er egentlig resultanten av normalspenninger som fordeler seg over tverrsnittet på en spesiell måte:



Overgangen mellom strekk- og trykkspenninger skjer i tverrsnittets nøytralakse hvor vi ikke har normalspenninger

For ren bøyning går nøytralakse gjennom arealsenteret.
For kombinert bøyning og aksiallast vil nøytralaksen flytte seg som vist på figuren over til høyre

d) Kontrollerer spenningsnivået i den vertikale bjelken hvor vi både har de største bøyemoment og normalkraft

$$\underline{\sigma} = \sigma_A + \sigma_B = \frac{2000}{896} + \frac{0{,}8 \cdot 10^6}{15{,}6 \cdot 10^3} = 2{,}2 + 51{,}3 = \underline{53{,}5\ MPa}$$

$$\underline{n} = \frac{\sigma_F}{\sigma} = \frac{355}{53{,}5} = \underline{6{,}6}$$

4a) I og med at skiven kan rotere fritt må de ytre kreftene danne momentlikevekt for at skiven skal være i ro

$\sum \vec{M}_C = 65 \cdot 30 + 15 \cdot 80 - 45 \cdot 70 = 0$ dvs statisk likevekt

Momentarmene leses av fra figuren

b) $\sum \vec{F}_x = 0$ gir $C_x + 65 \cos 30^\circ - 45 - 15 = 0 \Rightarrow C_x = 3{,}7\ N$

$\uparrow \sum F_y = 0$ gir $C_y + 65 \sin 30^\circ = 0 \Rightarrow C_y = -32{,}5\ N$

$$C = \sqrt{C_x^2 + C_y^2} = \sqrt{3{,}7^2 + 32{,}5^2} = 32{,}7\ N$$

$$\tan \varphi_C = \left| \frac{C_y}{C_x} \right| = \frac{32{,}5}{3{,}7} \Rightarrow \underline{\varphi_C = 83{,}5^\circ}$$